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Health Hazards in Mineral Assay Laboratories

Occupational Hazards and Incineration of Biomedical Wastes

The Role of the Ontario Ministry of Labour Nurse Consultants

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Occupational Health in Ontario

Volume 10, Number 3, Summer 1989

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Health Hazards in Mineral Assay Laboratories

Summary

The results of an occupational hygiene survey of 14 mineral assay labs carried out by the Health and Safety Support Services Branch (HSSSB) of the Ministry of Labour show there is potential for exposures to lead and silica. Such laboratories are advised of these potential hazards.

Key Words: silica, lead, arsenic, assessment, control program, industrial hygiene, air sampling, noise

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Introduction

There are potential occupational hazards in mineral assay laboratories, particularly in respect of lead, silica, arsenic and mercury, from operations such as ore preparation and fire assaying. Designated Substance Regulations for lead (Ont. Reg. 536/81), silica (Ont. Reg. 769/83), mercury (Ont. Reg. 141/82) and arsenic (Ont. Reg. 176/86) are prescribed under the *Occupational Health and Safety Act*, 1978. These regulations require assessments to be done to determine whether there is actual or potential exposure of workers to a designated substance and whether the health may be affected. The conclusion must indicate whether or not a control program is necessary. A control program includes provisions for engineering controls, work practices, hygiene practices and facilities, air monitoring and record keeping. In addition, medical surveillance is required in a control program for lead, silica and mercury. The regulations also set limits for the exposure of workers.

This preliminary occupational hygiene survey was conducted to audit worker exposure arising from the processes in a small sample of mineral assay laboratories and to note if assessments and control programs were in place.

The sample submitted to a mineral assay laboratory for metal analyses may be a rock or soil sediment. The rock samples are reduced to the appropriate particle size for laboratory analysis by using one or more of the following types of equipment/processes: jaw crusher, pulverizer, cone crusher, roller mills and rod/ball mills. The soil samples do not require particle size reduction.

In some situations a sieve shaker is used to separate out a specific particle size fraction. A riffle machine and a matting process may be used to divide the sample into portions and ensure that each portion is representative of the whole.

Fire assaying is carried out to determine precious metal content. The powdered rock samples (15 to 30 gm) are first mixed with lead flux, which may consist of:

litharge (lead oxide)
silica flour
borax
sodium carbonate

The sample and flux mixture contained in a fusion pot (capacity 150 mL) is heated inside a furnace (temp. 1,000°C) for 45 to 60 minutes.

The fused glass-like material is removed from the crucibles, cooled and broken up to release the 'lead button' formed at the bottom. These lead buttons are heated in another furnace in porous cupels to 950°C for 30 minutes. The lead is vaporized or absorbed into the cupels, leaving a silver bead (containing any precious metal originally in the sample) for subsequent analyses by spectroscopic methods.

Methods

Occupational hygiene visits were made by regional HSSSB occupational hygiene consultants to 14 mineral assay laboratories. Each visit included a walk-through survey of the laboratory to determine:

- process details
- number of workers exposed
- applicability of designated substances regulations
- process equipment used
- respirator usage
- flux ingredients and usage
- ventilation
- work practices
- awareness of designated substance requirements

Then the worker exposure was assessed by carrying out air sampling for silica and lead in a representative number of laboratories.

Results

In all, 14 laboratories were visited, and the following is a breakdown on the specific hazards identified.

Silica in 14 laboratories
Lead in 12 laboratories
Arsenic in four laboratories
Mercury in one laboratory

The number of workers potentially exposed to the various hazards in the 14 laboratories visited are shown in Table 1.

Table 1

Number of Workers Exposed			
Silica	**Lead**	**Arsenic**	**Mercury**
163	159	25	3

In one laboratory mercury was only used in minute quantities to prepare analytical standards, and exposure was judged to be minimal. Exposure to arsenic was found to be significant at one laboratory due to extremely high arsenic content in the ore being analysed.

Obtained during the walk-through survey were employers' assessments showing the methods used by the employer to examine the workplace exposure and the documentation for the existing control programs for designated substances used and considered hazardous in the laboratories. Table 2 shows the number of laboratories that had documented assessments for silica and lead at the time of the visit.

Table 2

Silica and Lead Assessments	
Documentation	**No. of Laboratories**
Silica	7
Lead	6

About half of the laboratories had not carried out formal assessments and were ordered to do so.

At two of the laboratories the lead contamination was from sources other than lead flux used for fire assaying. At one laboratory lead is used to a limited extent for preparing analytical standards, and, in another, lead is the major contaminant in the precious metal upgrading.

Table 3 outlines the number of laboratories that had documented control programs as required by the silica and lead regulations.

Table 3

Silica and Lead Control Programs	
Documentation	**No. of Laboratories**
Silica	6
Lead	8

Table 4 shows the adequacy of local exhaust ventilation for the sample preparation processes at the 14 laboratories visited following air flow measurements.

Table 4 **Ventilation for Sample Preparation**

No. of Laboratories	Ventilation
8	Adequate
5	Not Adequate
1	Not Provided

The sample preparation equipment itself was usually enclosed and ventilated but, in some cases, the pulverizers and motorized mortar and pestles were placed inside ventilated fume hoods. At five of the laboratories improved ventilation is required, and in one case, ventilation was not provided as it was not deemed necessary based on the volume of work processed.

Table 5 shows the various measures used by 10 laboratories (who carry out fire assaying) to control exposure to silica and lead in the flux preparation process.

Table 5 **Flux Preparation**

No of Laboratories	Control Measures
5	Pre-mixed
3	Ventilation
2	Respirators

Half of the laboratories used a pre-mixed flux that reduces worker exposure to lead and silica. Ideally, where large amounts of flux are prepared, ventilation controls should be used. In practice, a laboratory processing 80 lb per week was found to provide ventilation and at a laboratory using the most flux (two tons every four months), respirators were worn.

Most laboratories conducting fire assaying operations provide fume hood ventilation for weighing and canopy hoods over the furnaces and cooling processes (Table 6).

Table 6 **Ventilation for Fire Assaying Operations or Process Equipment**

No of Laboratories	Operation or Process Equipment
8	Weighing
10	Furnace
8	Cooling

Table 7 summarizes the air sampling results for silica conducted by HSSSB following the visits to six laboratories that were considered a representative sample.

Table 7 Airborne Silica Concentrations

Operation	Range (mg/m^3)	# of Samples	Total # of Samples above 0.10 mg/m^3	Total # of Samples above 0.20 mg/m^3
Ore Preparation	0.01 to 0.83	17 Personal 19 Area	14	9
Weighing and Fire Assaying	0.02 to 0.05	3 Personal 5 Area	none	none

The air sampling durations for the above surveys varied from 277 to 450 minutes and the results were considered representative of worker exposure over the entire shift. However, at the laboratory showing the highest personal results (0.37 mg/m^3 and 0.83 mg/m^3), eight-hour time-weighted average exposures were calculated, assuming no additional exposure for the period not sampled. In this case, the personal eight-hour exposures were calculated to be 0.23 mg/m^3 and 0.50 mg/m^3.

It is apparent from the above sampling results that the exposure to respirable quartz can be significant while preparing samples. Of the total 36 samples taken during ore preparation, 14 were in excess of 0.10 mg/m^3 with nine in excess of 0.20 mg/m^3 and these were taken on operators crushing and pulverizing the rock samples. The ventilation on crushers and pulverizers was found to be inadequate in each laboratory, hence improvement was ordered.

Table 8 shows the air sampling results for lead conducted by HSSSB at five laboratories visited.

Table 8 Airborne Lead Concentrations

Operation	Range (mg/m^3)	# of Samples	Total # of Samples at or above 0.15 mg/m^3
Ore Preparation	All N.D.	4 Personal 4 Area	None
Weighing and Fire Assaying	0.003 to 2.09	9 Personal 13 Area	3

The sampling durations for the above surveys varied from 194 to 400 minutes, with the majority near 350 minutes. It was generally assumed that the results were

representative of worker exposure over the entire shift. However, at one laboratory a five-hour personal sample of 0.16 mg/m^3 was converted to an eight-hour time-weighted average exposure of 0.10 mg/m^3, assuming no further exposure during the shift.

The above sampling results show that there is a potential for significant exposure to lead during weighing and fire assaying. At one laboratory the weighing room operator was exposed to 2.09 mg/m^3 lead while the area sample in the room was 0.15 mg/m^3. The downdraft ventilation provided was considered inadequate, and improvement in control was ordered.

Table 9 summarizes the air sampling results for arsenic obtained by HSSB at one laboratory.

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Table 9 Airborne Arsenic Concentrations

Operation	Range (μg/m^3)	# of Samples	Total # of Samples at or above 10 μg/m^3
Ore Preparation	2 to 130	7	6
Weighing and Fire Assaying	0.20 to 10.0	11	1

At the one laboratory where HSSSB carried out air sampling for arsenic the airborne arsenic concentration appeared to be related to the grade of ore processed. During the processing of non-local ore with low arsenic content, the air sampling results were all below 10 μg/m^3. However, when local ore was processed (arsenic content 35 per cent), seven of 12 results exceeded 10 μg/m^3. Three personal results of 80, 90 and 130 μg/m^3 when converted to eight-hour time-weighted average exposure (assuming no exposure for period of the shift not sampled) became 33, 41 and 123 μg/m^3. This clearly shows that where the ore contains a significant content of arsenic, workers' exposure can be significant. At this laboratory there was a control program for arsenic including medical surveillance.

Discussion

Workers in mineral assay laboratories may be potentially exposed to silica, lead, arsenic and mercury. While the major hazards encountered were silica and lead, arsenic exposure was considered significant in one laboratory since the ore processed could contain up to 35 per cent.

At almost half of the laboratories visited silica and lead assessments were not carried out by the companies. There was some misconception of what constituted an assessment. In many situations air sampling data alone were perceived as sufficient documentation. Air sampling data are only one aspect of an assessment, and results below the TWAE do not ensure that a control program is not necessary. It is difficult to quantify the worker exposures from company air sampling data for silica since, in many cases, the sampling durations and the worker activities during air sampling were not provided. However, it would appear that there is a potential for excessive silica exposure during sample preparation (i.e. pulverizing). For example, at one company six of the nine personal respirable quartz samples taken on workers pulverizing and crushing rock samples showed results above 0.10 mg/m^3, and three of these results were in excess of 0.20 mg/m^3. The highest result was 0.51 mg/m^3. Caution must be used in interpreting these results since no sampling times were given. However, they are not inconsistent with long-term sampling by HSSSB. At another company four of the five personal respirable quartz samples were in excess of 0.20 mg/m^3 during pulverizing and sample sorting. Again, no sampling durations were given with these data.

Likewise, no analysis can be made on the company air sampling data for lead. However, at one company 11 of 15 personal TWA samples were in excess of 0.15 mg/m^3, and one result was as high as 0.79 mg/m^3. Exposure to lead can occur when:

i) preparing lead flux
ii) weighing out lead flux
iii) fusing samples in the furnace
iv) cooling molten metal

Most mineral assay laboratories did not have documented silica and lead control programs. One item of confusion was the situation where controls are present but a formal program has not been documented. Some assume that since existing controls are present and preventing worker exposure, no control program is required. Existing control measures may provide adequate worker protection; however, the health of workers may still be affected should these controls fail or be maintained improperly. If this conclusion is reached, then a control program must be developed that incorporates existing control measures and other mandatory provisions as required by the regulation.

There appears to be an increasing trend towards the use of pre-mixed lead flux. This practice eliminates the need to prepare lead flux and thus reduces exposure to lead and silica.

The use of high-pressure air to blow away dust from equipment is a common practice as vacuum systems may not be efficient to remove dust from narrow areas. However, high-pressure air not only creates a problem of secondary dust emission but can also present a safety hazard due to trauma.

Disposable respirators approved for dust and mist were most commonly used in the sample preparation area. There are often questions about when a new disposable respirator should be provided. As with a replaceable filter respirator, the filter should be changed if the user experiences difficulty in breathing when dust builds up on the filter medium. For a disposable respirator, a new entire set must be provided when the filter needs to be changed. This is also required if straps break or become stretched.

Summary of Findings

A total of 14 laboratories were visted. Exposure to silica was found in the rock grinding and crushing department. The flux used in the assay contains silica and lead oxide. Lead fumes are generated during the evaporation of 'lead buttons'.

The findings are summarized as follows:

1. Silica and lead represent the major contaminant exposure; although arsenic and mercury may also be present they do not pose significant hazards.
2. About half of the laboratories visited had no required documented assessments and control programs for silica and lead.
3. There is a growing trend towards the use of pre-mixed flux containing lead, thus reducing the lead exposure.
4. The results of air sampling by both HSSSB and the companies indicate a potential for significant exposure to silica and lead.

Conclusion and Recommendation

This survey has shown that there is a potential for significant silica exposure during sample preparation using such equipment as crushers and pulverizers. Significant exposure to lead can occur during preparation and weighing of fluxes and fire assaying. It is recommended that all mineral assay laboratories in the province

need to carry out assessments for silica and lead and possibly arsenic with the view to establishing proper control programs.

Résumé

Une enquête menée dans le cadre de l'hygiène au travail par la Direction des services de soutien de la santé et de la sécurité au travail (D.S.S.S.T.) du ministère du Travail et qui portait sur 14 laboratoires de tests minéralogiques a révélé l'existence de risques d'exposition au plomb et à la silice, risques dont ces laboratoires ont été mis au courant.

Acknowledgment

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Occupational Hazards and Incineration of Biomedical Wastes

Summary

Potential for worker exposure to the products of combustion in the incineration facilities of four Ontario hospitals is described. Strict adherence to the Ministry of the Environment guidelines for packaging and disposal of biomedical waste is essential. Worker exposure to products of combustion during incineration is considered unlikely based on the adequacy of ventilation. Use of appropriate respiratory protection is advised during ash removal.

Key Words: waste management process, biomedical waste, infectious, incinerators, combustion gases, mutagenic

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Introduction

Standards have been set for the segregation, collection, movement, storage, disposal and incineration of waste material within health care facilities by: the Ontario Ministry of the Environment (MOE), Ontario Regulation 309 made under the *Environmental Protection Act*[1], the Canadian Standards Association (CSA Standard Z 317.10-88)[2], World Health Organization (WHO-EURO reports and studies 97)[3] and other similar organizations. The objective for such standards is to decrease the possible risks of the spread of infection, exposure to health hazards and injury to personnel handling the biomedical waste. These regulatory requirements and other guidelines are intended to establish criteria for the development of a healthy environment within health care facilities.

Biomedical wastes present a special problem in disposal as they cannot be disposed of in landfill sites, and, therefore, have to be incinerated. In Ontario over 130 incinerators are located on health care facility properties to dispose of biomedical wastes generated during daily hospital operation. Recent environmental studies have shown that the discharge from the incinerator stacks may contain measurable levels of toxic substances such as dioxins and furans produced during combustion of chlorinated plastics such as polyvinyl chloride (PVC). Not only does the presence of the toxins necessitate a designed control for general emissions, it also raises some concerns regarding the health and safety of workers involved in the health care facility's biomedical waste management program. This survey was undertaken both to address the concerns of potential worker exposure to the products of combustion during incineration and to the ash during ash removal and to review the general biomedical waste management program. The study involved a complete walk-through of four Ontario hospitals by a team of hygienists, safety officers and a physician, followed by detailed evaluation and measurement of contaminants by a team of hygienists and hygiene technologists.

The four hospitals were chosen to represent a cross

section of hospital incinerators in use in Ontario. To maintain consistency of information collected, a survey protocol was developed prior to the initiation of the visit.

Waste Management Process

The four community hospitals range in size from 316 to 660 beds. Each hospital generates the following types of waste:

1. **General Refuse**
   General office and kitchen garbage, bagged for landfill.

2. **Biomedical Waste**
   (i) Pathological – human anatomical waste or animal anatomical waste (in many hospitals this waste is shipped out of the province for disposal).

   (ii) Infectious – waste of any type that is contaminated or suspected to be contaminated with the causative agents of infectious disease or their toxic products. Under 'universal precautions', which most hospitals have now adopted, all waste that has come into contact with patients is considered infectious. This type of waste is generally segregated, packaged and colour-coded for further handling, storage, decontamination or transportation. In many cases this type of waste is autoclaved before incineration.

The infectious wastes and, in some cases, the pathological and general refuse (excluding kitchen garbage), are incinerated on site. Mechanical exhaust is not provided in any of the incinerator chambers; however, in most cases, fresh air for combustion is mechanically provided in the chamber. The room housing the incinerator is mechanically exhausted and makeup air is supplied. In some cases there is provision for local canopy exhaust over the incinerator door to prevent escape of incinerator gases and dust from the incinerator.

In all the hospitals visited the incinerators are fired by natural gas/air mixture and operated at a temperature of up to 2,000°F, depending on the type of waste. The incinerators are operated on a continuous or batch burn basis.

After the burning cycle, the incinerator chamber is allowed to cool and the ashes are removed. The ash removal process varies from shovelling the ash out of the chamber into buckets to pushing the ash down a

chute onto a conveyor or into a container. The ash may or may not be wetted during this process.

Occupational Hazards

The operators involved in the entire process are likely to be exposed to the biohazards by inhalation or contact while removing the biomedical waste from the source of generation, transporting the waste to the incinerator, loading the incinerators and removing the ash (especially when unburned residue is present in the ash). Workers may also be exposed to the airborne combustion products during the process of incineration and to the residual ash during repair and preventive maintenance procedures.

1. Biomedical Waste Handling

(i) Waste Packaging

In all hospitals visited, waste generated in patient care areas, laboratories and pathology departments is treated as hazardous waste and is packaged in colour-coded plastic bags. Sharps (needles, scalpels, etc.) are placed in rigid plastic containers. In some cases, pathological waste from the laboratory is steam autoclaved before transportation to the incinerators. Generally, these practices conform to the recommended MOE Guidelines for the Handling and Disposal of Biomedical Wastes from Health Care Facilities and Laboratories (1986);[4] however, some hospitals' waste is not double-bagged, as recommended. In one such hospital, considerable leakage of fluids, including blood on the waste transport trolley, the floor of the hallways and the floor of the incinerator room, was observed. In addition, many waste bags were noted to be punctured and damaged. In such cases, worker exposure to biological agents (by inhalation and by skin contact) is likely, and appropriate control measures should be instituted, including provisions for spill clean-up procedures.

It is recommended that procedures are implemented as outlined in the above-mentioned MOE Guideline, including the following: colour-coding the waste bags; double-bagging the waste with the inner bag (3 mil thickness) sealed, and the outer bag labelled, indicating the type of waste contained.

(ii) Spill Clean-up

In three of the four hospitals a spill clean-up procedure was documented. In two of these hospitals the procedure was not being enforced. Procedures for the handling and clean-up of hazardous waste spills should be developed and documented where they do not exist since these procedures are important in the prevention of the spread of disease through biomedical wastes. In addition, workers should be trained in these procedures and the potential hazards of handling such materials. These procedures should include containing and disinfecting the spill while using appropriate personal protective equipment (gloves, splash goggles, respirators, etc.). The spilled material should be removed and discarded in accordance with proper waste handling procedures, and the area of the spill disinfected. Tools, hands and respirators should also be cleaned and disinfected.

2. Incineration

(i) Incinerator Ash

In three of the four hospitals the incinerator combustion of the waste appeared to be complete since no residual unburned or partially burned waste was observed in the ash. In the fourth hospital, there was evidence of partially burned material in the residual ash, and, therefore, potential exposure to the biohazards after the incineration process exists. Appropriate steps, including worker training and the use of personal protective equipment, should be undertaken to prevent such an exposure.

The hospital should take measures to ensure complete combustion of the biomedical waste. Such measures may include regular maintenance of burners, changing the fuel mixture, increasing the time or temperature of the burn, etc.

(ii) Combustion Gases

The process of incineration will produce a wide variety of combustion products depending upon the materials being burned, the temperature of the incinerator and the amount of air being supplied. In general, the main combustion products are likely to be carbon dioxide (CO_2) and in the case of incomplete combustion, possibly some carbon monoxide (CO). Polyvinyl chloride

(PVC) and other plastic containers may give rise to a variety of chlorinated combustion products such as hydrogen chloride (HCl), dioxins and furans depending upon the temperature of heating.

Worker exposure to these contaminants during incineration is judged to be unlikely in the hospitals visited, based on the following observations and measurements:

(a) Smoke tube tests and air velocity measurements indicated strong negative pressure in the incineration chamber, suggesting air flow into the incinerator (not into the workplace from the incinerator). Negative pressure was observed also when the incinerator door was open during charging or inspection. The negative pressure in the incineration chamber is primarily due to the 'stack effect' or the height of the dedicated exhaust stack as mechanical exhaust is not provided. Combustion products are, therefore, unlikely to be present in the incinerator room.

(b) CO_2 (which is significant in quantity in combustion products) was used as an indicator of potential leakage of combustion products. Continuous CO_2 measurements covering the period before, during and after the incineration process in the area outside the incinerator showed no appreciable changes, therefore indicating no leakage of combustion gases into the workplace. CO_2 levels were similar to those found in fresh air (350 ppm to 400 ppm), with the exception of some transient peaks, which were attributed to human respiration in the vicinity of the CO_2 monitoring meter.

Carbon monoxide (CO) was found to be below the limit of detection (< 2 ppm), confirming that the combustion products are not leaking into the workplace.

(c) Hydrogen chloride concentrations were below the limit of detection except in two samples. These two samples are not judged to be indicating leakage as there is potential for sample contamination due to the use of bleach (containing the chloride ion) as a disinfecting agent in the incinerator room. In

any case, the measured HCl concentrations in these two samples are below the ceiling exposure standard of 5 ppm.

(d) Dioxins and furans could not be measured due to the unavailability of equipment. However, in view of the evidence against incinerator leakage and the presence of adequate ventilation, it may be concluded that worker exposure to airborne dioxins and furans is unlikely.

3. Ash Removal

(i) Ash Composition

In addition to carbon, incinerator ash may contain some carbonates, oxides and trace amounts of metals such as cadmium, lead, barium, aluminum, iron, etc. The toxicological properties of residual ash will vary according to the content of the waste burned. Bulk samples of ash from the four hospitals were analysed for metal content and the results are shown in Table 1.

Table 1 **Metal Composition of Ash (% of Total Weight)**

	Metals											
Hospital	**Al**	**Fe**	**Zn**	**Pb**	**Ag**	**Cd**	**Cr**	**Cu**	**Mn**	**Ni**	**Sn**	**Se**
1	6	0.5	0.3	0.1	ND	ND	ND	ND	ND	ND	ND	—
2	7	0.5	0.3	ND	ND	ND	ND	ND	ND	ND	ND	—
3	8	—	0.3	0.1	—	—	—	8	—	—	—	—
4	11	—	0.1	0.2	—	—	0.1	0.3	0.1	—	—	0.1

ND = not detected at respective detection limits
— = not analysed.

(ii) Exposure to Airborne Dust

Operator exposure to airborne ash during ash removal was measured as total dust, and the concentrations found are summarized in Table 2.

Table 2 **Air Sampling Results Total Dust Exposure**

Hospital	**Total Dust (mg/m^3)**
1	1.1 to 21.0
2	2.0 to 5.1
3	0.07 to 2.17
4	0.13 to 1.22

The amount of airborne dust generated was related to the amount of water used for dust suppression, the position of the operator and the amount of shovelling and handling required to remove the ash from the incinerator chamber. Work practices contribute significantly to the dust generated in the work environment, and, therefore, the documented levels may vary significantly.

Although the results given in Table 2 are time-weighted average concentrations over the period of ash removal and the workers are not exposed to these levels eight hours per day, worker exposure to dust must be reduced to as low as practicable because of the uncertainty of the ash content. In one study, ash from one of the incinerators was found to be Ames test positive, indicating that it may possibly contain a mutagen. Due to the variable nature of the ash and its suspected mutagenic character, no exposure limit can be assigned. Under such circumstances, the prudent practice will be to control worker exposure to airborne dust to as low as is reasonably achievable.

To reduce worker exposure to dust during ash removal, dust suppression techniques such as wetting the ash with water before removal, handling, transport or storage should be used, supplemented by the use of a respirator equipped with HEPA filters. The HEPA filter is capable of filtering 99.97 per cent of particles greater than 0.3 microns in diameter. Steps should be taken to ensure that the wetting technique does not create dust itself; for example, a fine spray of water should be used. Open incinerator ash storage containers and conveyors should be enclosed as much as possible. In addition, work practices should be reviewed to ensure that the dust generated during the handling of the ash is minimized.

(iii) Exposure to Airborne Metals

The total dust samples were analysed for the metals detected in the bulk samples to determine operator exposure to airborne metals. The results are shown in Table 3.

Table 3 Air Sampling Results
Range of Concentration of Airborne Metals (mg/m^3)

	Metals					
Hospital	**Al**	**Fe**	**Zn**	**Pb**	**Ba**	**Se**
1	0.04-0.81	0.02-0.05	0.008-0.04	ND-0.03	ND to 0.03	ND-0.008
2	0.03-1.2	0.008-0.06	ND-0.04	—	—	—
3	0.001-.02	—	ND	ND	ND	—
4	0.001-0.01	—	ND	ND	ND	.001 to .006
*Exposure Standard	10.0	5.0 (a)	10.0 (b)	0.15	0.5	0.2

(a) referenced as welding fume (iron containing)
(b) referenced as zinc oxide fume (as zinc)

*Denotes the exposure standard as given in Ontario Reg. 654/86 and/or Ontario Reg. 536/81.

The duration of operator exposure to the airborne metals is less than one hour; therefore, potential for exposure to individual metals listed in Tables 1 and 2 above their respective exposure criteria is judged unlikely.

(*iv*) *Exposure to Airborne Lead*

In one hospital (No. 1) there is measurable exposure to a low concentration of lead (0.03 mg/m^3 averaged over a one-hour period). Because lead is present and worker exposure by inhalation is likely, the Regulation respecting Lead (Ont. Reg. 536/81) applies (section 3) and an assessment for worker exposure to lead is required (section 6). It is concluded, however, that the worker's health is unlikely to be affected due to the low airborne lead concentrations and the short duration of exposure (up to one hour per shift, three times per week). A lead control program, as per the regulation, may not be necessary.

In two hospitals where trace amounts of lead were found in the bulk samples (Table 1), lead was not detected in the air samples (Table 2). In view of the low concentration of lead in the ash and the absence of detectable airborne lead, worker exposure to lead is considered unlikely in these hospitals, and, therefore, the Regulation respecting Lead (Ont. Reg. 536/81) is not applicable.

4. Personal Protective Equipment

The personal protective equipment being used in each of the four facilities is summarized in Table 4.

Table 4
Personal Protective Equipment Being Used at Each of the Four Facilities

Hospital	Boots	Headcover	Respirator	Coveralls	Safety Glasses/ Goggles	Gloves
#1 Before and During Loading	Safety Boots	'TYVEK	Respirator (non-toxic dust)	Cotton Work Clothes	Chem-Splash Goggles	Leather Gloves
Ash Removal	"	"	"	"	"	"
#2 Before and During Loading	None	None	None	Work Clothes	None	Latex Gloves
Ash Removal	Knee High Safety Boots	None	NIOSH Approved Dust-OV Respirator	Cotton Coveralls	Eye Goggles	Leather Gloves
#3 Before and During Loading	Safety Shoes	Available But Not Worn	None	Cotton Coverall	None	Latex Gloves
Ash Removal	Safety Boots	Available But Not Consistently Worn	NIOSH Approved OV Respirator	Cotton Coverall Heat Resistant Apron	Goggles	Heat Resistant Gloves
#4 Before and During Loading	Safety Shoes	Not Consistently Worn	None	Cotton Lab Coats	None	Not Consistently Worn
Ash Removal	Safety Boots		Surgical Masks	Cotton Uniform Lab Coat	Faceshield	Heat Resistant Gloves

In most hospitals the personal protective equipment used by the worker before and during loading may be considered adequate; however, the use of leather

gloves where latex gloves are being used at present should be encouraged. In general, respirators were not worn during loading. If the bags are properly sealed and there are no leaks, then respirators are not required. However, it was noted, at least in one hospital, that bags were punctured and damaged, which may allow the inhalation of biological agents, therefore requiring appropriate respiratory protection. During ash removal it is imperative that NIOSH approved respirators equipped with HEPA filters, impervious head covers, coveralls and leather gloves be used. The requirements for such usage and training for the use, care and maintenance of such protective equipment were not present in any of the hospitals visited and should be provided.

Personal protective equipment should include as a minimum:

(a) half-facepiece respirator with NIOSH approved HEPA filters.

To ensure effectiveness of the respiratory protection, a comprehensive respirator management program should be put in place and should include:

- a program co-ordinator
- selection of appropriate respirator
- fit testing
- storage facilities
- care, use and maintenance
- worker training;

(b) chemical splash goggles to protect the eyes from the splash of infectious material;

(c) leather gloves to provide protection from sharp picks and a barrier against the infectious material. If the gloves become wetted with waste liquid, they should be removed and disinfected.

(d) coveralls or aprons and head covers should be used, especially during the ash removal. This equipment should be left in the incinerator area to prevent contamination of other work areas. Coveralls or aprons (work clothes if coveralls/aprons are not used) should be laundered on site or by a competent contractor.

The use of this equipment should also be encouraged by maintenance workers, including outside contractors who may perform the maintenance on the incinerators.

5. Hygiene Practices

To prevent further contamination of employees and other persons, employees should wash with soap and water before eating, drinking or smoking after carrying out their waste disposal duties. At the end of the incinerator loading and ash removal cycles, showering is advised.

6. Medical Surveillance

The hospitals presently carry out pre-placement medicals and periodic medical examinations, including immunization and health education. In some hospitals the medical surveillance program is not specific to the biomedical waste handlers, but is appropriate to all personnel in 'high risk' jobs.

The MOE Guidelines for the Handling and Disposal of Biomedical Wastes from Health Care Facilities and Laboratories (1986), referred to earlier, recommend the issuance of a letter by the hospital administration to the employee's physician, outlining the work procedures and potential occupational risks. This is not done at any of the four hospitals. As this practice allows the personal physician to be alerted to the possibility of the employee contracting an occupational illness, it is advised that this recommendation be followed.

Conclusions

There is potential for health care workers to be exposed to biological agents during the collection, transport and loading of biomedical wastes for incineration. In the four hospitals investigated, worker exposure to combustion gases produced during the incineration process (CO_2, CO, HCl, dioxins, furans, etc.) was not considered likely. While carrying out ash removal after the incineration is complete, there is potential for significant worker exposure to airborne incinerator ash, a low concentration of airborne metals (lead, iron, aluminum, zinc), and some bioaerosols present in the ash due to incomplete combustion.

Due to the variable nature of the biomedical waste and the suspected mutagenic character of the incinerator ash produced, it is important that control measures are implemented to reduce worker exposure to potential hazards. The hospital should ensure that combustion is complete during incineration, that the incinerator room is adequately ventilated and that all measures are taken to suppress airborne ash levels. Employees should be educated in the potential hazards involved

with their job and in spill procedures, proper packaging and labelling of waste and the importance of proper personal hygiene (handwashing, showering, etc.). Personal protective equipment, including a NIOSH approved HEPA respirator, safety footwear, protective coveralls and headwear, chemical splash goggles and leather gloves, should be worn during the incinerator loading and ash removal procedures. A medical surveillance program specific for the incinerator operator is recommended.

Résumé

Les risques d'exposition des travailleurs aux produits de combustion dans les incinérateurs de quatre hôpitaux ontariens sont décrits ci-dessus. Il est essentiel de suivre strictement les directives établies par le ministère de l'Environnement en ce qui concerne l'empaquetage et l'élimination des déchets biomédicaux. On estime que l'exposition des travailleurs aux produits de combustion pendant l'incinération est improbable en raison du fait que la ventilation est adéquate. Il est recommandé d'utiliser un équipement de protection respiratoire approprié lors de l'enlèvement des cendres.

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References

[1]Ontario Regulation 309 made under the Environmental Protection Act.

[2]Canadian Standards Association. Handling of Waste Materials Within Health Care Facilities (CSA-Z317, 10-88) June 1988.

[3]World Health Organization. Management of Waste from Hospitals EURO Reports and Studies 97, 1985.

[4]Ministry of the Environment Guidelines for the Handling and Disposal of Biomedical Wastes from Health Care Facilities and Laboratories, 1986.

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The Role of the Ontario Ministry of Labour Nurse Consultants

Summary

The role of the Ministry of Labour nurse consultants is described, and their primary activities are outlined with the emphasis being on medical surveillance audits, health service and health promotion consultations. The consultants' services are provided to the Ministry of Labour inspectorate, occupational or private physicians, occupational health nurses, educational institutions, company management, union health and safety representatives and individual workers.

Key Words: nurse consultant, medical surveillance audits, health promotion

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The Health and Safety Support Services Branch within the Ontario Ministry of Labour's Occupational Health and Safety Division currently employs 11 nurse consultants. The services of the branch, including those of the nurse consultants, are provided through seven offices located throughout the province.

The nurse consultants provide consultation and advice to all personnel concerned with occupational health in the province. The recipients of these services may be the inspectorate of the Ministry of Labour, occupational or private physicians, occupational health nurses, industrial clinic personnel, educational institutions, company management, union health and safety representatives or individual workers.

At the present time, the primary activities of the ministry's nurse consultants involve:

1. The auditing of medical surveillance programs required under Ontario's designated substance regulations.
2. Health service consultations to provide advice on the establishment and development of occupational health services in Ontario workplaces.
3. Health promotion consultations to provide guidance on the establishment and development of preventive health programs for Ontario workers.

Auditing of Designated Substance Medical Surveillance Programs:

In Ontario potentially hazardous biological, chemical or physical agents may be prescribed by regulation as 'designated substances'. These regulations have been instituted to ensure that workers are adequately protected from the adverse health effects of excessive exposure to the substances. At the present time, the following substances have been designated and regulations made to control the use of the substance in the workplace: lead, mercury, silica, asbestos, isocyanates, coke oven emissions, benzene, acrylonitrile, vinyl chloride, arsenic and ethylene oxide.

A control program is required whenever exposure to the substance used in the workplace may affect the health of a worker.

The control program must include provisions for engineering controls, work and hygiene practices, air monitoring, record keeping, training and, in all regulations with the exception of arsenic and ethylene oxide, a specific medical surveillance program.

Auditing of the medical surveillance aspect of the control program is necessary to ensure compliance with the regulation.

A medical surveillance audit encompasses all sections of the designated substance regulations that pertain to medical surveillance. When the nurse consultant visits the workplace, the audit is always conducted by discussion with both management and worker joint health and safety committee representatives as well as with the health professionals providing the program. This ensures that worker and management representatives understand the required components of medical surveillance and the responsibilities of the examining physician. These representatives must also understand the joint health and safety committee's responsibility to review control measures when the physician identifies any adverse health effects that may be due to exposure to the substance.

Components of Medical Surveillance Required Under the Designated Substance Regulations

The following factors are assessed by the nurse consultant during a medical surveillance audit:

1. Number of Exposed Workers

The employer's control program must clearly indicate the areas of the workplace where the designated substance is handled and where a worker is likely to so inhale, ingest or absorb the substance that his/her health may be affected. All workers who fall into this category must be included in the control program and must take part in the prescribed medical surveillance.

The experience of the nurse consultants has emphasized the importance of including worker and management joint health and safety committee representatives in the conduction of a medical surveillance audit. There may be disagreement by committee members on the number of workers exposed and the particular workers to be included in the medical surveillance program. In such cases, the medical or hygiene consultants of the Ministry of Labour would be requested to clarify

exposure areas so that the particular workers to be included in the control program may be determined.

2. Examining Physician

Each regulation requires the appointment of an examining physician to conduct the prescribed medical examinations and clinical tests. The regulations do not stipulate who the examining physician should be, which allows the worker to select the physician of his/her choice. The examining physician may be the company physician, a part-time physician who contracts with the employer, a physician on the staff of an industrial medical clinic or the worker's own family physician.

The nurse consultant may contact the designated examining physician to review the components of the required medical surveillance.

In some cases there may be several designated examining physicians in one company, e.g. the company physician, a clinic physician and several workers' own family physicians. In this situation, advice is given to the employer regarding methods of providing information to the physicians to ensure their knowledge of the requirements of the appropriate Code for Medical Surveillance as well as the physician's responsibilities.

3. Medical Examinations and Clinical Tests

All of the Codes for Medical Surveillance of the designated substance regulations outline the requirements for pre-placement and periodic medical examinations as well as particular clinical tests.

During an audit visit the purpose of these examinations and tests is explained to management and worker health and safety representatives. Medical conditions that may be aggravated by exposure to the designated substance should be detected at the time of pre-placement medical assessment. Periodic medical assessment may detect adverse health effects; the physician can then alert the employer and the joint health and safety committee to exposure problems in the workplace where controls should be reviewed to detect deficiencies.

The consultant also reviews the frequency of medical examinations and clinical tests with the examining physician. In some cases the frequency of examinations and tests is left to the discretion of the examining physician. The decision regarding frequency is based on the results of previous clinical tests and the extent of worker exposure to the substance. In some cases a maximum interval for periodic examination is stated in

the Code for Medical Surveillance (e.g. for silica and asbestos, periodic medical examination must be arranged at least every two years).

Advice on local resources available for clinical testing is often provided to the examining physician. The services of the Ministry of Labour's Occupational Health Laboratory and Chest Clinic are outlined, where appropriate.

Some of the regulations (e.g. lead and mercury) require the physician to advise the joint health and safety committee, in writing, of the results of clinical tests, along with an opinion of how these tests should be interpreted. The nurse consultant ensures that these results are provided to the committee and that committee members handle the information in a confidential manner. The committee is advised that the purpose of the provision of these results is to enable them to monitor the control program to ensure that deficiencies in control measures are identified at an early stage and that remedial action is taken.

4. Worker Health Education

Education for workers on the health effects of the designated substance and precautionary measures to be followed to limit exposure is a critical factor to be included in the medical surveillance program.

The consultant checks that the examining physician or occupational health nurse provides this health information to workers at the pre-placement and periodic medical assessments.

In some cases this information is provided by the nurse on the staff of an industrial clinic. Companies that employ occupational health nurses are encouraged to arrange for the nurse to provide these educational sessions. The ministry's nurse consultants often provide health education sessions upon request to groups of workers at small businesses who do not employ a nurse and where resources are limited.

5. Record Keeping

The Code for Medical Surveillance of each regulation lists the components that must be included in the individual's health record.

During a medical surveillance audit these files are reviewed to ensure that all the statutory components are included. Where a clinic is utilized for medical surveillance a visit to the clinic is arranged to discuss record-keeping requirements with the staff.

The nurse consultant also reviews with the examining physician and occupational health nurse the requirement for medical information to be maintained in a confidential manner.

The requirement for the examining physician to maintain the workers' medical records for a specific time is also reviewed (40 years from the earliest date of the records or for 20 years from the latest date, whichever is longer).

6. Personal Exposure Records

The rationale for the maintenance of personal exposure records, i.e. to record variances in the level of exposure over time, is discussed with management and worker health and safety representatives. The regulations specifically outline the components of the personal exposure records, i.e. the worker's name, date of birth, exposure time, use of respiratory equipment and type, as well as air sampling results.

A copy of the personal exposure records must be provided to the examining physician to ensure the physician is aware of the frequency and extent of exposure. This information will assist the physician to determine the frequency of medical examinations and clinical tests, and the medical record will contain this information for the statutory period.

Where personal exposure records are not being currently maintained the nurse consultant will provide advice to the employer on the method or format for recording the exposure information.

7. Fitness Notification Requirements

The regulations have several notification requirements for the examining physician. These requirements are always reviewed by the nurse consultant during an audit of the medical surveillance program.

In most cases the examining physician is required to advise the employer and the worker following medical assessment whether the worker is fit, fit with limitations or unfit for exposure to the substance. The physician's opinion regarding the worker's fitness is given to the employer without disclosing the results of the examinations or tests.

If a physician determines that a worker is unfit or fit with limitations for exposure to the designated substance, he or she is required to communicate this advice in writing to the joint health and safety committee. As previously mentioned, this will enable the

committee to review the adequacy of control measures. In addition, if the physician judges a worker to be unfit or fit with limitations for continued exposure to the substance, he or she must communicate this information to the chief physician of the Occupational Health Medical Service of the Ministry of Labour. This information will allow the ministry consultants to investigate the control procedures at the workplace to ensure their adequacy.

Where the nurse consultant finds non-compliance with the sections of the regulations pertaining to medical surveillance, advice is provided to management and the joint health and safety committee regarding the upgrading required. In such cases the Ministry of Labour's inspectorate is also advised to issue the appropriate order to the employer to ensure compliance with the regulation.

Health Service Consultations

The Ministry of Labour nurse consultants frequently provide advice on the administration and development of workplace employee health services. These services vary considerably depending upon the size and type of industry.

Some employers and labour groups require basic information regarding hazard identification and first aid requirements. The nurse consultant will assist the smaller employer with an assessment of needs in these areas. The employer is advised that the *Workers' Compensation Act* outlines specific standards for first aid requirements. Regulation 950, incorporated into the *Workers' Compensation Act*, outlines the requirements for first aid equipment, facilities and training of employees.

Assistance is often provided to management and worker representatives for the establishment of a first aid facility. A review and advice with respect to location, equipment, records, accessibility and supplies may be provided. Advice on documentation procedures and establishment of policies for control of hazards in the workplace as well as treatment of occupational and non-occupational injuries and illness may be provided by the consultant.

Management and the worker representatives may wish to extend their first aid program to include the development of a more preventive health and safety program. Employers may elect to utilize an occupational health clinic to provide cost effective health services. The nurse consultants are aware of clinic facilities in

the various areas of the province, and, in many cases, they have met with clinic staff to review the delivery of their programs. Employers considering the use of an occupational clinic may be referred to local clinic facilities by the nurse consultants.

Numerous small to medium-sized companies are currently considering the establishment of an occupational health nursing service. This service may be provided by an occupational health nursing firm or by an occupational health nurse employed directly by the company. These nursing services may be provided on either a part-time or a full-time basis.

The occupational health nurse is often the sole health professional on site. His/her ability to identify potential health hazards is essential, and he/she should advise management and workers of resources available to assist in the control of the hazard. An occupational health nurse (OHN) is a registered nurse who maintains a current certificate of competence with the College of Nurses of Ontario (CNO). The college is a self-regulating body under the *Health Disciplines Act*. Its purpose is to ensure that the public receive safe, effective and ethical nursing care.

Although primary care remains a vital component of an occupational health nurse's service, he/she should also play a key role in the education of workers and the prevention of health risk factors.

The nurse consultants give advice to employers who are considering the establishment of an occupational health service. The consultant informs management and labour regarding the Standards of Nursing Practice (i.e. performance expectations) established by the CNO. The evolution of occupational health nursing from merely the provision of first aid and primary care to the current role of the OHN is also outlined. The focus of the OHN today is the prevention of illness and injury by educational programs.

In addition to providing the employer with information on which to make an informed decision regarding the employment of a nurse, the consultant may also assist with the transition phase after the occupational health nurse has been employed.

The nurse consultants are prepared to assist employers with the orientation of newly hired occupational health nurses. There are variations in occupational health nursing education backgrounds, and, to be most effective, these consulting visits are often conducted over a period of time. Priorities for activity are established by the needs of the employer, nurse and workers re-

garding the health service programs (i.e. designated substances, hazardous substances, injury/illness rates, health promotion programs).

If the nurse has had limited or no preparation in this field, he/she may require advice on the basic principles and policies of occupational health. Advice may also be provided on nursing functions in an occupational health unit, the causes, treatment and prevention of occupational illness and injury, and regulatory requirements for OHNs. The nurse is always encouraged to consider membership in professional nursing associations. This contact is particularly useful for nurses who function alone in the workplace.

The nurse consultant also may provide information regarding courses at universities and community colleges in the nurse's area. Several occupational health nursing diploma and certificate courses are offered throughout the province. These courses include such topics as toxicology and early disease detection, basic industrial hygiene, health service administration, health assessment and principles of health education and promotion.

A certification process for occupational health nurses was established in Canada during 1984. This was the first nursing specialty to establish national certification. This certification will assure the employer in future that the nurse is aware of changes and developments in this field because of the ongoing requirement for continuing education.

The nurse consultant is also a resource for the established occupational health nurse. Consultation is often provided on the development and maintenance of employee health services and programs. Advice or direction may be provided on numerous topics such as: health service administration, medical confidentiality, record keeping, medical directives, regulatory requirements, health assessments, community resources, accommodation, equipment and continuing education.

The nurse consultants are also available to provide guidance on occupational health issues to other interested groups, such as educational institutions and health care agencies (public health and hospital personnel).

Health Promotion Consultations

Health promotion is the process of encouraging individuals to assume responsibility for maintaining and improving their health. A health promotional program assists an individual to identify health risks and then teaches behaviour modification to eliminate them. A considerable number of diseases that contribute to dis-

ability and increased absenteeism are a result of lifestyle. More employers are now considering the introduction of health promotion programs in the workplace to encourage healthier lifestyles. Information on the availability of resources in the community that provide health promotion programs can be provided by the nurse consultants. A variety of health promotion programs are available that focus on smoking cessation, fitness, nutrition, blood pressure control, stress management and/or employee assistance programs. The success of any program is dependent upon a supportive organizational climate. The consultant is able to discuss with the client groups the numerous components that contribute to successful programs (e.g. top management and union involvement, accurate identification of appropriate programs, voluntary participation, confidentiality, trained or capable program staff, accessibility and evaluation).

Although many larger companies have provided health promotion programs for several years, smaller employers with fewer resources have not generally provided these workplace programs to any degree. The ministry's nurse consultants are available as a resource to provide direction to the smallest employer regarding availability and accessibility to health promotion activities in their particular area.

The nurse consultants may be contacted through the regional Ministry of Labour offices located throughout the province.

Résumé

On décrit le rôle des experts-conseil en soins infirmiers du ministère du Travail et leurs principales activités, plus particulièrement la surveillance médicale et les consultations pour les services de santé et la promotion de la santé. Ces services sont fournis aux inspecteurs du ministère du Travail, aux médecins (qu'ils travaillent au sein d'entreprises ou qu'ils aient leur propre cabinet), aux infirmières de la santé au travail, aux établissements d'enseignement, aux responsables de la gestion des sociétés, aux représentants syndicaux de la santé et de la sécurité au travail et aux travailleurs.

Recent Publications Available From the Government Book Store

Regulations	Workplace Hazardous Materials Information System — made under the Occupational Health and Safety Act Ontario Regulation 644/88
	Hazardous Materials Inventories — made under the Occupational Health and Safety Act Ontario Regulation 643/88
Support Literature	A Guide to the WHMIS Regulation.

News and Notes

Physical Agent Fact Sheets

The following fact sheets have been developed by the Health and Safety Support Services Branch of the Ministry of Labour to assist workers in Ontario to understand better the health hazards associated with hand-arm vibration, noise, cold stress and heat stress. The basic preventive measures are described and the exposure limits are referenced.

Hand-Arm Vibration

Hazard

Vibration from hand-held tools such as pneumatic jack hammers and drills, chainsaws and electrical grinders may cause health effects depending on the intensity and duration of exposure.

Description

The vibration characteristic of a tool may be measured by instruments attached directly to the handle of the tool or through a finger-held transducer mount. Accelerometers detect and transmit the vibrations from 2-2,000 Hz through a frequency-weighted filter to a meter for direct reading or to a magnetic tape for subsequent analysis. The frequency weighted root-mean-square (rms) acceleration levels in three directions X, Y and Z are determined. The measured result in each direction is expressed as a single averaged acceleration level (Leq) in metres/sec^2 or as dB (10 m/s^2 = 140 dB).

Health Effects

The major health hazard is the development of hand-arm vibration syndrome (HAVS), which has three components:—

1. Circulatory disturbances — local finger blanching, Raynaud's phenomenon or VWF.
2. Neurological disturbances — numbness, loss of hand and finger dexterity.
3. Musculo-skeletal disturbances — loss of muscle power, bone and joint disturbances.

The commonest presenting symptom is the finger blanching on exposure to cold, with the neurological and muscular disturbances appearing later. In some workers the neurological features may predominate or be present on their own.

Onset of symptoms and signs depends on the dose of vibration (intensity and exposure time) and occurs after a short interval of a few months if the dose is high, or after many years if the daily/weekly dose of vibration is low.

The Stockholm scale 0-4 is now used for the grading of cold-induced Raynaud's phenomenon in subjects with the hand-arm vibration syndrome with a scale of 0-3SN for the sensorineural symptoms.

If vibration exposure is discontinued at Stage 2 a worker with circulatory disturbances may recover, but there is less evidence for sensory and motor disturbance recovery.

An increased hearing loss has been reported in young workers with Raynaud's phenomenon. Carpal tunnel syndrome is often associated with HAVS because of excessive grip force in the use of vibratory tools and the associated swelling of tissues. Dupuytren contracture is not thought to be induced by vibration, but may be aggravated by the associated manual activity.

Preventive measures

1. Use of anti-vibration devices to minimize or isolate vibration transmission to the hands.
2. Use of gloves with anti-vibration material.
3. Gripping the tool as lightly as possible but consistent with safe work practice.
4. Regular maintenance of tools to keep vibration to a minimum.
5. Reduction of exposure time by rotation of work when feasible.
6. Health education (i) avoid smoking to reduce the circulatory disturbances; (ii) wear extra clothing to maintain central body temperature, particularly in cold weather; (iii) workers with symptoms and signs of HAVS should seek medical specialist advice.

Exposure Limits

The following should be noted: —

ACGIH 1986-87
ISO 5349-1986 (E)
ANSI s3.34-1986
BSI 6842:1987

Noise

Hazard

Noise is sound undesired by the recipient; it is harmful or it interferes with normal activities, particularly with communication and efficiency.

Description

A sound-wave comprises a flow of energy through the air, causing displacement of particles, together with corresponding fluctuations in pressure, density and temperature. In practice, the majority of measurements are of sound pressure level (SPL) presented on the decibel scale (dB), and, when necessary, can be converted to sound intensity data. Sound intensity is defined as the sound energy flow per second across unit area perpendicular to the direction of propagation, and is proportional to the square of the pressures.

Sound level meters, used for noise measurement, have specific measurement ranges, weighting networks and often the capability for impulse measurement depending on the precision of the instrument. The correct choice of meter and microphone as well as proper calibration before and after use is essential for accuracy of measurement.

Noise measurements are usually taken to relate the noise to its effects on humans. The A-weighting network in a sound level meter corresponds to the loudness contour curve of the human ear (to sound over the frequency range 10-10,000 Hz). So measuring with the A-weighting (dBA) noises can be compared and the health hazard estimated.

Health Effects

Intense noise of any kind can cause temporary threshold shift (TTS) and/or permanent damage to the human hearing process.

Permanent noise-induced hearing loss (NIHL), defined as a permanent shift in the hearing threshold, does not seem to occur for equivalent continuous noise exposure level (Leq) below 80 dBA; however, it is significant at 85 dBA and becomes a major hazard to hearing when 90 dBA is exceeded.

Impulsive noise from an explosion or from gun fire may, in addition to causing damage to the inner ear, rupture the ear-drum as a single event. Ringing in the ears called 'tinnitus' is often associated with severe hearing loss.

There are large variations in individual susceptibility to noise damage, but it is not possible to predict in advance who will be susceptible and who will not.

The non-auditory health effects of noise exposure include annoyance, sleep disturbance, and communication and work interference. Reported effects that are difficult to substantiate include blood pressure and hormone changes, visual disturbances, giddiness, stress and mental illness.

Preventive Measures

These include:

1. Identification and evaluation of sources of noise at and above 80 dBA.
2. Attenuation of noise by engineering controls as and when feasible.
3. Provision of appropriate hearing protection for workers exposed to noise at or above an Leq of 85 dBA for an eight-hour workday or to a peak SPL at or above 140 dB.
4. Periodic audiometric examinations for workers at risk.
5. Health education.

Heat Stress

Hazard

Working in a hot and humid environment can result in an increase in body core temperature. If there is too great a rise in this temperature the worker is at risk of developing heat induced illness, which ranges from excessive fatigue to collapse and, possibly, death.

Description

Heat stress occurs when there is an increase in the body core temperature as a result of environmental or work task demand factors. Heat balance is achieved when the heat generated by the body (metabolic heat) plus any heat gained from the environment (environmental heat) is equal to the heat lost from the body to the environment. This balance is affected by such factors as air velocity, humidity, type of clothing, degree of acclimatization, age, weight and degree of physical fitness.

The bodily response to total heat stress is called heat strain. Heat strain can occur when working in places such as laundries, bakeries and steel mills, but also, potentially, in any industry in the summer when environmental temperatures and/or humidity are high.

Health Effects

Heat Stroke
This is a life threatening condition that requires immediate medical attention. It is characterized by mental confusion, loss of consciousness and body temperature of 106°F. Without medical intervention the person will die.

Heat Exhaustion
Extreme fatigue, weakness and nausea arise out of an inadequate replacement of body fluids lost through perspiration. No significant increase in oral temperature is usually observable. Condition is readily reversible with the intake of fluids and rest.

Heat Cramps
Painful spasms of the skeletal muscles resulting from salt loss in perspiration. Salt ingestion can quickly relieve cramps.

Fainting
Unacclimatized workers who stand still for long periods are at risk because blood pools in legs and skin. Lying down and subsequent moving around reduces risk of recurrence.

Heat Rash
Arises from blockage of sweat pores by a continuous exposure to un-evaporated sweat. Can be prevented by showering and allowing skin to dry.

Prevention

Engineering Controls
- Control the heat at source through the use of insulating and reflective barriers.
- Exhaust hot air and steam produced by specific operations.
- Reduce the temperature and humidity through air cooling.
- Provide air conditioned rest areas.
- Increase air movement if temperature is less than 35°C.
- Reduce physical demands of work task through mechanical assistance.

Administrative Controls
- Increase the frequency and duration of rest breaks.
- Schedule hot jobs to cooler times of the day.
- Provide cool, potable drinking water close to the workers and encourage them to drink more than their thirst stimulates.

– Assign additional workers or slow down work pace.
– Implement a progressive schedule of heat acclimatization.
– Train workers to recognize the signs and symptoms of heat strain.

Personal Protective Equipment
– Provide air-, water- and ice-cooled or insulated clothing for short-term exposures.
– Clothing should allow free movement of perspiration and airflow.
– Reflective clothing can be used to reduce radiant heat gain.

Recommended Exposure Limits

Workers should not be permitted to continue their work when their deep body temperature exceeds 38°C. Since it is impractical to measure this temperature directly, an environmental index known as Wet-Bulb Globe Temperature (WBGT) is utilized. Using this index, it is believed that nearly all workers may be repeatedly exposed to the conditions in Table 1 and Figure 1 without any adverse health effects. The values apply to healthy, acclimatized workers who are wearing customary one-layer work clothing. Variations from these assumptions require modifications to Table 1 or Figure 1, as suggested in Table 2.

The values in Table 1, which have been derived from the data in Figure 1, apply if the work load is estimated according to the definitions:

Light: Sitting or standing to control machines; performing light hand or arm work (up to 200 kcal/hr).
Moderate: Walking about with moderate lifting and pushing (200-350 kcal/hr).
Heavy: Pick and shovel work; digging (≥ 350 kcal/hr).

The values in Figure 1 may be applied if the work load is determined by measuring the worker's metabolic rate while performing the job or by adding the values of: (1) basal metabolic rate; (2) metabolic rate for body position or motion; (3) metabolic rate for type of work; and (4) metabolic rate related to work speed.

For purposes of enforcement in Ontario, the values in Table 1 are generally used.

WBGT values are calculated by the following equations:

1. Outdoors with solar load:
   WGBT = 0.7 NWB + 0.2 GT + 0.1 DB
2. Indoors or Outdoors with no solar load:
   WBGT = 0.7 NWB + 0.3 GT

Where WBGT = Wet Bulb Globe Temperature Index
NWB = Natural Wet-Bulb Temperature
DB = Dry-Bulb Temperature
GT = Globe Temperature

Table 1 Threshold Limit Values (TLVs) for Heat Exposure Recommended by the ACGIH

Work — Rest Regimen (each hour)	WBGT (°C) for Different Work Loads		
	Light	Moderate	Heavy
Continuous work	30.0	26.7	25.0
45 min. work — 15 min. rest	30.6	28.0	25.9
30 min. work — 30 min. rest	31.4	29.4	27.9
15 min. work — 45. min. rest	32.2	31.1	30.0

Figure 1 **Permissible Heat Exposure Threshold Limit Values**

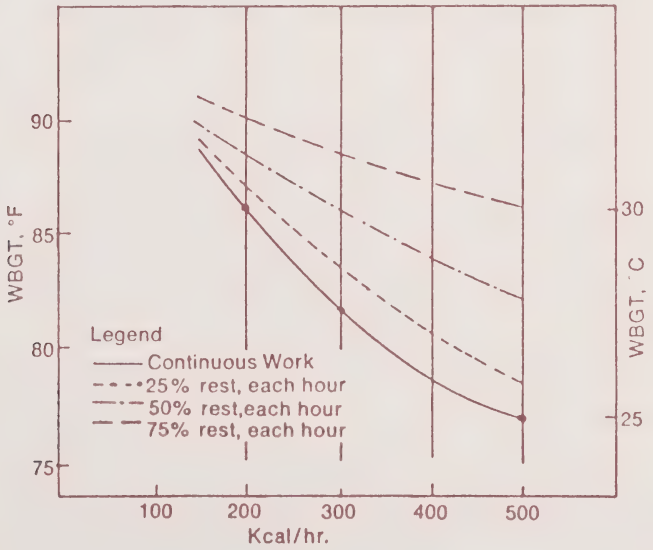


Table 2 **Suggested Modifications to Table 1 and Figure 1***

Condition	Suggested Change in Exposure Limit (°C)
Unacclimatized Worker	Subtract 2°C
Air Velocity over 1.5 m/s (5.4 km per hour)	Add 2°C
Clothing — shorts	Add 2°C
— body armour, impermeable jacket	Subtract 2°C

*(Adapted from 'Working in Hot Environments', Canadian Centre for Occupational Health and Safety)

Cold Stress

Hazard

Working in cold environments can result in a drop in deep body temperature (hypothermia) or freezing of the extremities (frostbite).

Description

Exposure to cold can result in a severe reduction in central body temperature (hypothermia) as well as tissue damage to peripheral body parts such as fingers and toes (frostbite). Working outside in winter and in cold storage facilities are the most frequent exposure situations. Increased risk arises when high air movement speeds or wet conditions are also present.

Health Effects

Hypothermia
When core temperature drops to below 35°C, maximum shivering is present. Further drops in temperature result in reduced mental alertness and rational decision making or loss of consciousness and threat of loss of life.

Frostbite
Freezing of some part of the body that results from continuous cold exposure or direct contact with extremely cold objects. Frostbitten skin is highly susceptible to infection and, therefore, gangrene.

Immersion and Trenchfoot
Tissue damage to the feet that results from prolonged exposure (days or weeks) to cold, damp conditions.

Prevention

Engineering Controls

- Provide heated areas for relief from the cold when equivalent chill temperatures are below −7°C.
- Utilize spot heating such as radiant heaters.
- Reduce air movement speeds with physical barriers.
- Metal handles should be covered with insulating materials.

Work Practice Controls

- Whole body acclimatization to cold does not occur, but tolerance by hands and feet can increase with gradual exposure.
- Increase the frequency and duration of rest breaks.
- Schedule jobs to warmer times of the day or other days.
- Provide warm drinks to replace lost body heat and fluids.
- Minimize sitting or standing still for prolonged periods.
- Work rate should not be so high as to cause heavy sweating.
- External clothing should be removed when workers enter warm areas in order to allow perspiration to evaporate.
- Train workers to recognize the signs and symptoms of cold strain.
- Workers should not work alone in extreme cold situations.

Personal Protection

- Undergarments should breathe and draw moisture away from the body.
- Outer garments should be impermeable to water if worker may get wet at job site and to air movement if high winds are present.
- Heated protective clothing should be provided if normal clothing does not provide sufficient protection.
- Provide gloves when contact of hands with cold surfaces may occur.

Recommended Exposure Limits

Workers should be protected from a core temperature drop below 36°C and from conditions that can result in cold injury to body extremities. It is believed that nearly all workers may be repeatedly exposed to the

conditions in Table 1 and Figure 1 without adverse health effects.

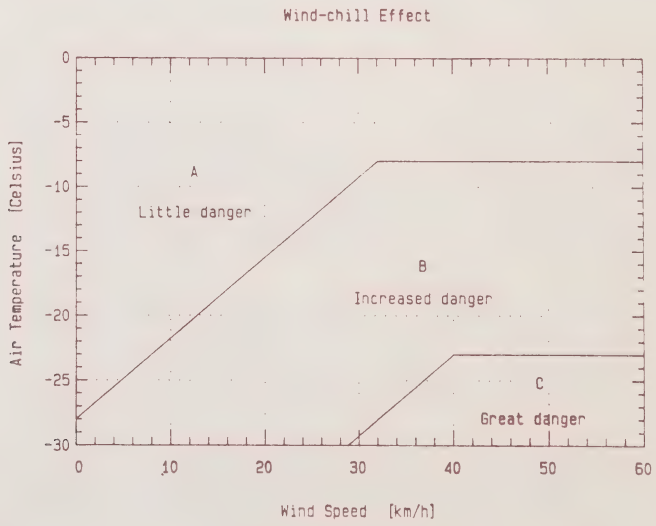
The schedule shown in Table 1 is intended to protect against hypothermia and applies to moderate-to-heavy work with breaks of 10 minutes in a warm location. For light-to-moderate work (little physical movement), apply the schedule one step lower. For example, at −35°C with no noticeable wind, a worker at a job with little physical movement should have a maximum work period of 40 minutes with four breaks in a four-hour shift instead of 55-minute work periods and three breaks.

Table 1

Air Temperature Sunny Sky °C	No Noticeable Wind		8 km/h Wind		16 km/h Wind		24 km/h Wind		32 km/h Wind	
	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
−26°C to −28°C	(Normal)	1	(Normal)	1	75 mins.	2	55 mins.	3	40 mins.	4
−29°C to −31°C	(Normal)	1	75 mins.	2	55 mins.	3	40 mins.	4	30 mins.	5
−32°C to −34°C	75 mins.	2	55 mins.	3	40 mins.	4	30 mins.	5	Non-emergency work should cease	
−35°C to −37°C	55 mins.	3	40 mins.	4	30 mins.	5	Non-emergency work should cease			
−38°C to −39°C	40 mins.	4	30 mins.	5	Non-emergency work should cease					
−40°C to −42°C	30 mins.	5	Non-emergency work should cease							
−43°C and below	Non-emergency work should cease									

Figure 1

Intended to Protect Against Freezing of Peripheral Tissue



Area A: There is little danger for dry skin exposed *for less than one hour* to the indicated air temperatures and wind speeds. However, there is great danger of having a false sense of security.

Area B: There is increasing danger of freezing of exposed flesh within one minute.

Area C: There is great danger since flesh may freeze within 30 seconds.

The 14th Semi-Annual Intensive Workshop in Industrial Hygiene. University of Toronto.

Monday, September 25, 1989 to Friday, September 29, 1989

These workshops are designed for those who, for the following reasons, would benefit by taking the course:

- To increase knowledge of their specialization in occupational hygiene;
- feel the need for a general refresher course;
- for recent entrants to the hygiene field who wish to broaden their back-ground knowledge of occupational hygiene.

The panel of lecturers includes Dr. John Steel, Dip.Occ.Hyg., from the Department of Occupational Health and Hygiene, Medical School, University of Newcastle-upon-Tyne, United Kingdom, personnel from the Ontario Ministry of Labour, and faculty and staff of the University of Toronto. The expertise of the speakers covers all relevant aspects of hygiene, risk assessment, human factors engineering, toxicology, occupational medicine and occupational health and safety legislation. A hands-on equipment demonstration and monitoring round-table are included in the workshop.

The Industrial Hygiene and Hazard Control Engineering Program of the University of Toronto presents the workshops bi-annually. Professor J.W. Smith, Ph.D., C.Eng., C.I.H., chairman of the Department of Chemical Engineering and Applied Chemistry is the program co-ordinator.

Enquiries should be addressed to:

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(416) 978-6615

Ministry of Labour		Fiscal Year	Amount $
Applied Research Awards Since Inception to Date	Alberti, P. University of Toronto/ Mt. Sinai Hospital 'Speech Intelligibility with Ear Protectors' 004/R	78/79 79/80	33,323.00 34,777.00
	Sefton, M.V. University of Toronto 'Foam Monitor for Detection of Toxic Vapours' 023/R	77/78	55,770.00
	Phillips, C.R. University of Toronto 'Development of an Instant Meter to Measure Radon Daughters' 031/R	77/78	80,000.00
	Roberts, R.S. McMaster University 'Mortality Study of Ontario Nickel Workers (INCO)' 033/R	78/79 79/80	91,100.00 34,000.00
	Morgan, R.W. University of Toronto 'Reproductive Outcomes in Wives of Coke-oven Workers' 037/R	78/79 79/80 less funds returned	57,121.00 14,000.00 −3,753.26
	Frey, J.D. Haileybury School of Mines 'A Study of Mine Conveyance Safety Catches and Guide Design' 040/R	79/80 80/81 81/82 less funds returned	12,720.00 12,720.00 12,720.00 −693.14
	Lees, R.E.M. Queen's University 'Non-Auditory Effects of Noise in an Industrial Population' 048/R	77/78	23,908.51

	Fiscal Year	Amount $
Sarma, D. University of Toronto 'Are Environmental Chemicals Hazardous for Human Tissues?' 052/R	78/79 79/80 80/81	20,455.00 22,267.00 24,364.00
Chamberlain, M.J. University of Western Ontario University Hospital 'Radionuclide Contamination of Laboratory Workers' 061/R	78/79 less funds returned	15,588.00 −1,649.50
Stopps, G.J. University of Toronto 'Survey of Hazardous Materials Used in the Contruction Industry' 066/R	78/79 less funds returned	5,000.00 −605.28
Stopps, G.J. University of Toronto 'Distribution of Asbestos Dust in Commonplace Construction Activities' 067/R	78/79 less funds returned	4,560.00 −1,308.84
McCalla, D. McMaster University 'Mutagenicity and Lung Cancer in a Steel Foundry' 077/R	78/79 79/80	73,408.00 48,533.00
Shannon, H.S. McMaster University 'A Retrospective Mortality Study of Nickel Workers (Falconbridge)' 085/R	79/80	95,955.00
Morgan, W.K.C. University of Western Ontario 'Factors Influencing the Regional Deposition of Inhaled Particles' 089/R	79/80 80/81	19,910.00 19,250.00

	Fiscal Year	Amount $
Kalow, W. University of Toronto 'Method for Testing Human Plasma Paraoxonase' 091/R	79/80	11,350.00
Gauldie, J. McMaster University 'Increased Disease Susceptibility After PCB Exposure' 92/R	80/81	56,623.00
Stuchly, S.S. University of Ottawa 'Interaction of Electromagnetic Fields with Biological Tissues' 095/R	79/80 80/81 81/82	52,820.00 55,450.00 50,000.00
Smith, J.W. University of Toronto 'Control of Sulphuric Acid Aerosols in All Rooms' 101/R	79/80 80/81	23,288.00 19,870.00
Verma, D.K. McMaster University 'Lung Dust Study' 103/R	79/80 80/81 81/82	23,900.00 22,940.00 11,431.00
Perley, M. Canadian Environmental Law Research Foundation 'The Workplace Environment: A Legal Guide' 109/R	79/80	9,000.00
Able, S.M. Mt. Sinai Hospital 'Hearing Protectors: Signal Detection in Industrial Noise' 113/R	80/81 81/82 82/83 less funds returned	67,526.00 66,146.00 9,070.00 −18,204.00

	Fiscal Year	Amount $
Cherian, M.G. University of Western Ontario 'Chelation of Cadmium and Its Use in Occupational Health' 114/R	80/81 81/82	37,400.00 78,425.00
Muir, D.C.F. McMaster University 'Relationship Between Environmental Exposure and Silicosis' 122/R	80/81	18,756.00
Popplewell, D. Ontario Research Foundation 'Development of Metatarsal and Sole Protection Evaluation Techniques' 123/R	79/80	53,111.00
Lawson, A. Ontario Research Foundation 'Emission of Underground Diesels' 127/R	80/81 81/82 82/83 83/84 84/85	102,000.00 85,900.00 167,634.00 92,800.00 40,000.00
Hollebone, B.R. Carleton University 'Correlations Between Improved Tests for Lead Burden and Lead Intoxication' 129/R	82/83 83/84	60,500.00 63,000.00
Sefton, M.V. University of Toronto 'Development of Stain Length Passive Dosimeters' 132/R	80/81 82/83	40,550.00 59,305.00
Athey, J.A.B. Ontario Research Foundation 'Development of a Standard for Firefighters' Turn-out Coats' 134/R	80/81 81/82	4,270.00 36,722.00

	Fiscal Year	Amount $
Scott, B. University of Windsor 'Lead Toxicity of Human Tissues' 144/R	83/84 84/85	32,062.00 37,331.00
Sarma, D.S.R. University of Toronto 'Induction of Preneoplastic Hepatocytes: A Rapid Bioassay for Chemical Carcinogens' 146/R	82/83 83/84 84/85	19,134.00 37,541.00 37,349.00
Verma, D.K. McMaster University 'Lung Dust Study—Phase II' 147/R	82/83 83/84 84/85	33,208.00 26,752.00 29,946.00
Michalko, K.J. Ottawa General Hospital McMaster University and Toronto General Hospital 'Mutagenic and Chromosomal Study in Nurse Handling and Administering of Anticancer Agents' 149/R	82/83 83/84 84/85 85/86	50,000.00 18,811.00 145,975.00 37,775.00
Morgan, W.K.C. University of Western Ontario 'Effect of Exercise on Regional Deposition of Particles' 153/R	82/83	4,000.00
Muir, D.C.F. McMaster University 'Proposed Epidemiology Survey of Hardrock Miners in Ontario: A Summary of Methodology' 159/R	82/83 83/84 84/85	80,000.00 100,000.00 20,000.00

	Fiscal Year	Amount $
Stuchly, S.S. University of Ottawa 'Measurements of the Permittivity of Animal and Human Tissues in Vivo and Vitro' 160/R	83/84 84/85 85/86	40,684.00 96,520.00 68,110.00
Haines, T. and Muir, D.C.F. McMaster University 'Firefighters Heart and Lung Study' 161/R	84/85 86/87	38,700.00 23,900.00
Woo, G.C. University of Waterloo 'Are There Subtle Changes in Vision After Prolonged Use of VDTs?' 165/R	84/85 85/86	31,560.00 30,167.00
McCalla, D.R. McMaster University 'Characterization of Steel Foundry Mutagens' 172/R	84/85 85/86 86/87	72,650.00 78,462.00 84,739.00
Gibson, Rosalind S. University of Guelph 'Evaluation of Serum, Urine and Hair Cr Levels as Indices of Cr Exposure and the Relationship of these Indices to Serum Lipids' 175/R	85/86 86/87	35,061.00 25,232.00
Abel, Sharon M. Mt. Sinai Hospital 'The Attenuation of Hearing Protectors in Relation to Design and Fit' 176/R	84/85 85/86 86/87	93,665.00 72,603.00 79,551.00
Muir, D.C.F. and Nieboer, E. McMaster University 'Biological Monitoring of Ontario Cadmium Workers' 178/R	84/85 85/86 86/87	52,723.00 115,030.00 251,466.33

	Fiscal Year	Amount $
Chong, John McMaster University 'Occupational Environmental Risk Factors for Dementia—A Pilot Study' 187/R	85/86	68,100.00
Sarma, D.S.R. University of Toronto 'Induction of Hepatic Nodules: A Rapid Bioassay for Chemical Carcinogens' 190/R	85/86 86/87	45,486.00 103,750.00
Kapuski, George J. Wellesley Hospital 'Seroepidemiologic Survey of Susceptibility of Vericella' 191/R	84/85	1,750.00
Broder, I. Gage Research Institute 'Respiratory Study of Control Workers and Employees in a Nickel Smelter' 192/R	85/86 86/87	95,490.00 26,232.00
Kerenyi, N.A. Sunnybrook Medical Centre 'Light Pollution and Malignant Melanoma' 194/R	85/86 86/87 87/88	52,855.00 52,103.00 51,900.00
Holness, D.L. St. Michael's Hospital 'Respiratory and Cutaneous Effects of Hard and Soft Wood Exposure' 195/R	85/86	88,898.00
Nethercott, J.R. St. Michael's Hospital 'Acute and Chronic Health Effects of Formaldehyde Exposure' 196/R	85/86	39,000.00

	Fiscal Year	Amount $
Muir, D.C.F. and Shannon, H.S. McMaster University 'Fibreglass Mortality Study' 198/R	85/86 86/87	50,000.00 2,078.28
Verma, Dave McMaster University 'Study of Dusts, Metals and Fibres in Urban Lungs' 205/R	86/87	45,000.00
Purdham, James University of Toronto 'The Evaluation of Exposures of Operating Room Personnel to Potentially Harmful Environmental Agents' 207/R	86/87 87/88	47,063.00 2,900.00
Pilger, Charles University of Toronto 'New Procedure for Determination of Airborne Isocyanates' 209/R	86/87	23,149.00
Lees, R.E.M. Queen's University 'Influence of Shift Duration on Injury and Morbidity' 213/R	86/87 87/88	35,875.00 26,290.00
Martin, Alexander University of Western Ontario 'Electromagnetism and Development' 214/R	86/87	12,250.00
Eastwood, M.R. Clarke Institute of Psychiatry 'Investigation for Neurotoxic Effects of Aluminum Prophylaxis in Ontario Mines' 219/R	86/87 87/88	34,900.00 147,340.00

	Fiscal Year	Amount $
Purdham, James University of Toronto 'Evaluation of Exposure of Printing Trade Workers to Polycyclic Aromatic Hydrocarbons' 220/R	87/88	28,936.00
Choi, B.C.K. University of Toronto 'Factors Affecting Urinary Mutagenic Level of Workers with Bladder Cancer' 221/R	86/87	60,139.00
Morgan, W.K.C. University Hospital 'Body Habitus and Regional Particle Deposition' 222/R	87/88	12,833.00
Wells, R.D. University of Waterloo 'Repetitive Strain Injuries of the Hand and Forearm: Measurement and Identification of Predictive Factors' 224/R	87/88	41,778.00
Helewa, Antoine University of Western Ontario 'A Randomized Health Care Trial Comparing Abdominal Muscle Strengthening Exercises and Back Education to Reduce the Incidence of Low Back Pain' 225/R	87/88	117,040.00
Stuchly, S.S. University of Ottawa 'Studies of Human Exposure to Man-Made Electric and Magnetic Field Transients' 226/R	87/88	75,887.00

	Fiscal Year	Amount $
Haines, A.T. McMaster University 'Pilot Study of Past and Present Ethylene Oxide Exposed Hospital Workers' 227/R	87/88	80,285.00
Webber, Colin Chedoke-McMaster Hospitals 'Bone Lead Measurements' 228/R	87/88	24,613.00
Nethercott, J.R. St. Michael's Hospital 'Follow-up Study of Occupational Contact Dermatitis' 229/R	87/88	33,580.00
Ranadive, Narendranath University of Toronto 'Phototoxicity of the Compounds Related to Occupational, Therapeutic and Cosmetic Exposure' 231/R	87/88	41,080.00

Coming Events

July 10-13, 1989	Society of Occupational Medicine – Annual Conference, BRISTOL, ENGLAND. For further information, contact: SOM, 6 St. Andrew's Place, Regents Park, London, England, NW1 4LB.
August 28–30, 1989	International Conference on Blood-Borne Infections in the Workplace. STOCKHOLM, SWEDEN. For further information, contact: International Conference on Blood-Borne Infections, CONGREX AB, P.O. Box 5619, S-114 86 Stockholm, Sweden.
August 28–September 1, 1989	CLIMA 2000 – Second World Congress on Heating, Ventilation, Air Conditioning and Refrigeration. SARAJEVO, YUGOSLAVIA. For further information, contact: CLIMA 2000, Masinski Fakultet, Prof. Dr. E. Kulic, 71000 Sarajevo, Omladinsko Staliste 66, Yugoslavia.
September 5–7, 1989	5th International Meeting on Low Frequency Noise and Vibration. OXFORD, ENGLAND. For further information, contact: Dr. W. Tempest, Multi-Science Publishing Co. Ltd., 107 High Street, Brentwood, Essex, England, CM14 4RX.
September 11–14, 1989	Work with Display Units 89. MONTREAL, QUEBEC, CANADA. For further information, contact: General Secretary, Institut de recherche en santé et en sécurité du travail du Québec (IRSST), 505, boulevard de Maisonneuve ouest, Montréal, Québec, Canada, H3A 3C2.
September 17–21, 1989	First World Congress on Accident and Injury Prevention. STOCKHOLM, SWEDEN. For further information, contact: Stockholm Convention Bureau, P.O. Box 6911, S-10239, Stockholm, Sweden. Phone +46-8-230990.

September 17–22, 1989	Ninth International Symposium on Chlorinated Dioxins and Related Compounds. TORONTO, ONTARIO, CANADA. For further information, contact: O. Hutzinger, Dioxin '89, Conference Management, c/o Congress Canada, 73 Richmond St. West, Ste. 300, Toronto, Ontario, Canada M5H 1Z4.
September 26–29, 1989	XVII Medichem. CRACOW, POLAND. For further information, contact: Institute of Occupational Medicine, 8 Teresy St., P.O. Box 199, 90-m950 Lodz, Poland.
October 3–6, 1989	Occupational Medical Association of Canada – Annual Meeting. HALIFAX, NOVA SCOTIA, CANADA. For further information, contact: Dr. J.D. Prentice, Maritime Tel & Tel Company Ltd., 1505 Barrington St., Halifax, NS, Canada, B3J 2W3.
October 11–13, 1989	7th International Symposium on Epidemiology in Occupational Health. TOKYO, JAPAN. For further information, contact: Secretariat, 7th International Symposium on Epidemiology in Occupational Health, Department of Preventive Medicine and Public Health, School of Medicine, Keio University, 35 Shinano-machi, Shinjuku Ward, Tokyo 160, Japan.
November 16–17, 1989	International Conference on Air, Water and Environmental Pollution and Hazardous Wastes. NEW DELHI, INDIA. For further information, contact: Dr. V.M. Bhatnagar, P.O. Box 1779, Cornwall, Ontario, Canada, K6H 5V7.
May 6–11, 1990	XII World Congress on Occupational Safety and Health. HAMBURG, FRG. For further information, contact: Hamburg Messe und Congress GmbH, Postbox 302480, D-2000 Hamburg 36, Federal Republic of Germany.
July 29–August 3, 1990	5th International Conference on Indoor Air Quality and Climate. TORONTO, ONTARIO, CANADA. For further information, contact: Centre for Indoor Air Quality Research, University of Toronto, 223 College St., Toronto, Ontario, Canada, M5T 1R4.

September 22–28, 1990	23rd International Congress on Occupational Health. MONTREAL, QUEBEC, CANADA. For further information, contact: Dr. M. Lesage, Chairman of the Organizing Committee, 84 rue de Brésoles, Montréal, Québec, Canada, H2Y 1V5.

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